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(54) **Cylinder sleeve assembly**

Zylinderlaufbuchsenanordnung

Assemblage de chemise de cylindre

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(73) Proprietor: **THOMAS INDUSTRIES, INC.**  
**Sheboygan Wisconsin 53082-0029 (US)**

(72) Inventors:  
• **Lynn, William**  
**Kohler, Wisconsin 53044 (US)**

• **Thomas, Paul**  
**Sheboygan Falls, Wisconsin 53085 (US)**  
• **Armfield, Gerald**  
**Fond du lac, Wisconsin 54935 (US)**

(74) Representative: **Patentanwälte Ruff, Wilhelm,**  
**Beier, Dauster & Partner**  
**Postfach 10 40 36**  
**70035 Stuttgart (DE)**

(56) References cited:  
**EP-A- 0 446 006**                      **EP-A- 0 744 541**  
**WO-A-97/05382**                      **US-A- 3 712 759**  
**US-A- 5 584 675**

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**Description****CROSS REFERENCES TO RELATED APPLICATIONS**

[0001] This application claims the benefit of U.S. Provisional Application No. 60/033,813, filed on March 7, 1997.

**STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH**

[0002] Not Applicable

**BACKGROUND OF THE INVENTION**

[0003] This invention relates to axial piston fluid pumping apparatus, and more particularly to an assembly of parallel cylinder sleeves for the axial pistons.

[0004] International Patent Application No. PCT/US96/12362 filed July 24, 1996, for "Fluid Pumping Apparatus" and published as International Publication No. WO97/05382, discloses a compact axial piston pumping apparatus assembled from stacked components. The disclosure of the international application is hereby incorporated by reference as though fully set forth herein. One of the stacked components of the axial piston pumping apparatus is a cylinder sleeve member formed as a single extruded aluminum element. The cylinder sleeve member includes a large central opening and three cylinder bores symmetrically disposed about the central opening and parallel with each other. The central opening receives the shaft of a drive motor which mounts the pistons that operate in the cylinder bores.

[0005] The present invention is directed to an alternative construction for such a cylinder sleeve.

**SUMMARY OF THE INVENTION**

[0006] In accordance with the invention, a plurality of identical cylinder sleeve elements interlock with each other to form a large central opening and symmetrically spaced cylinder bores. The cylinder sleeve elements may include other integral features such as bolt receptors to receive through bolts which connect the cylinder sleeve assembly with other of the stacked components that make up the axial piston fluid apparatus. The identical cylinder sleeve elements may be formed of extruded aluminum.

[0007] It is a principal object of the invention to provide an assembly of parallel cylinder sleeves formed of identical interlocking elements.

[0008] The foregoing and other objects and advantages of the invention will appear in the detailed description which follows. In the description, reference is made to the accompanying drawings which illustrate a preferred embodiment of the invention.

**BRIEF DESCRIPTION OF THE DRAWING****[0009]**

Fig. 1 is a view in perspective of a cylinder sleeve assembly in accordance with the invention;  
Fig. 2 is a view in perspective of an individual cylinder sleeve element which forms the assembly of Fig. 1; and  
Fig. 3 is an end view of the cylinder sleeve element.

**DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT**

[0010] The cylinder sleeve assembly is formed of three identical cylinder sleeve elements 10. Each of the elements 10 includes a circular cylindrical portion 11 and an integral circular arc portion 12. The arc portion 12 is tangent to the cylindrical portion 11. The cylindrical portion 11 defines a cylindrical bore 13 in which a piston will operate. One end of each arc portion 12 is formed with a boss 15 having an opening 16. The other end of each arc portion 12 is formed with an offset finger 17 which mates with the opening 16 in the boss 15 of an adjacent element 10. As shown in the drawing, three elements 10, when joined together, interlock to form an assembly which includes a large central opening 18 defined by the arc portions 12 of the elements 10.

[0011] The elements 10 may also include integral bolt receptors 20 extending from opposite sides of the cylindrical portion 11 to receive through bolts for connection of the cylinder sleeve assembly with other components of an axial piston device.

[0012] Each element 10 can be formed as an aluminum extrusion. Extruding the separate elements 10 allows greater accuracy in holding the tolerances for the cylindrical bores 13 of the sleeves and for the symmetrical spacing of the sleeves relative to each other.

[0013] Although the preferred assembly includes three cylinder sleeve elements, any multiple of such elements could be employed. The assembly could be formed of two or more individual cylinder sleeve elements by adjusting the sweep of each arc portion.

**Claims**

1. A cylinder sleeve assembly for an axial piston pumping apparatus, said assembly defining a central opening and a number of cylinders radially equiangularly spaced around said opening, said assembly comprising the same number of cylinder sleeve elements (10), each said element (10) having a circular cylindrical portion (11) which defines one of said cylinders and a connecting portion integrally formed with said circular cylindrical portion (11), said connecting portion defining a portion of said central opening, and means at opposite ends of

each said connecting portion for connecting the connecting portions of adjacent sleeve elements (10).

2. A cylinder sleeve assembly as claimed in claim 1, wherein the sleeve elements (10) are identical to one another. 5
3. A cylinder sleeve assembly as claimed in claim 1 or 2, wherein said connecting portion of each said sleeve element (10) is in the form of a circular arc (12), and is oriented at a tangent to the circular cylindrical portion (11) of said sleeve element (10), so that said central opening (18) is circular. 10
4. A cylinder sleeve assembly as claimed in one of the claims 1 - 3, wherein said means at opposite ends of each said connecting portion comprises a boss (15) at one end which defines an opening (16) that extends in a direction parallel to the axial direction, and a finger (17) at the opposite end of said connecting portion of a shape that mates with the boss (15) of an adjacent connecting portion so as to fix the adjacent sleeve elements (10) together radially. 15
5. A cylinder sleeve assembly as claimed in claim 4, wherein said opening (16) and finger (17) are L-shaped in radial cross-section. 20
6. A cylinder sleeve assembly as claimed in one of the claims 1 - 5, wherein at least one bolt receptor (20) is formed integrally with each said cylinder sleeve element (10). 25
7. A cylinder sleeve assembly as claimed in claim 6, wherein each said bolt receptor (20) is formed integrally with said circular cylindrical portion (11). 30
8. A cylinder sleeve assembly as claimed in one of the claims 1 - 7, wherein each said sleeve element (10) is made by extrusion. 35
9. A cylinder sleeve assembly as claimed in claim 8, wherein each said sleeve element (10) is aluminum. 40

#### Patentansprüche

1. Zylinderlaufbuchsenanordnung für eine Axialkolbenpumpvorrichtung, wobei die Anordnung eine zentrale Öffnung und eine Anzahl von um die Öffnungen radial mit gleichem Winkelabstand angeordnete Zylinder und die gleiche Anzahl von Zylinderlaufbuchsenelementen (10) aufweist, von denen jedes Element (10) einen kreiszylindrischen Abschnitt (11), der einen der Zylinder bildet, und einen einstückig mit dem kreiszylindrischen Abschnitt 45

(11) gebildeten Verbindungsabschnitt aufweist, der einen Teil der zentralen Öffnung bildet, sowie Mittel an entgegengesetzten Enden jedes Verbindungsabschnitts, zum Verbinden der Verbindungsabschnitte benachbarter Buchsenelemente (10).

2. Zylinderlaufbuchsenanordnung nach Anspruch 1, bei der die Buchsenelemente (10) untereinander identisch sind.
3. Zylinderlaufbuchsenanordnung nach Anspruch 1 oder 2 bei der der Verbindungsabschnitt jedes Buchsenelements (10) in der Form eines Kreisbogens (12) ist und in einer Tangente an den kreiszylindrischen Abschnitt (11) des Buchsenelements (10) orientiert ist, so dass die zentrale Öffnung (18) kreisförmig ist.
4. Zylinderlaufbuchsenanordnung nach einem der Ansprüche 1 bis 3, bei der die Mittel an entgegengesetzten Enden jedes Verbindungsabschnitts einen Vorsprung (15) an einem Ende, der eine in einer Richtung parallel zu der axialen Richtung verlaufende Öffnung (16) definiert, und einen Finger (17) an dem entgegengesetzten Ende des Verbindungsabschnitts mit einer Form aufweist, die zu dem Vorsprung (15) eines benachbarten Verbindungsabschnitts passt, um so die benachbarten Buchsenelemente (10) radial aneinander zu befestigen.
5. Zylinderlaufbuchsenanordnung nach Anspruch 4, bei der die Öffnung (16) und der Finger (17) in einem radialen Querschnitt L-förmig sind.
6. Zylinderlaufbuchsenanordnung nach einem der Ansprüche 1 bis 5, bei der mindestens eine Bolzenaufnahme (20) einstückig mit jedem Zylinderlaufbuchsenelement (10) gebildet ist.
7. Zylinderlaufbuchsenanordnung nach Anspruch 6, bei der jede Bolzenaufnahme (20) einstückig mit dem kreiszylindrischen Abschnitt (11) ausgebildet ist.
8. Zylinderlaufbuchsenanordnung nach einem der Ansprüche 1 bis 7, bei der jedes Buchsenelement (10) durch Extrusion hergestellt ist.
9. Zylinderlaufbuchsenanordnung nach Anspruch 8, bei der jedes Buchsenelement (10) aus Aluminium ist.

#### Revendications

1. Un assemblage de chemise de cylindre pour un appareil de pompage à pistons axiaux, ledit assemblage formant une ouverture centrale et un nombre 55

de cylindres disposés de manière équi-angulaire autour de ladite ouverture, ledit assemblage comprenant le même nombre d'éléments de chemise de cylindre (10), chacun desdits éléments (10) ayant une partie cylindrique circulaire (11) laquelle forme un desdits cylindres et une partie de liaison faisant partie intégrale de ladite partie cylindrique circulaire (11), ladite partie de liaison formant une partie de ladite ouverture centrale et des moyens à l'extrémité opposée de chaque partie de liaison pour attacher les parties de liaison des éléments de chemise (10) adjacents.

2. Un assemblage de chemise de cylindre selon la revendication 1, où les éléments de chemise (10) sont identiques les uns aux autres.
3. Un assemblage de chemise de cylindre selon la revendication 1 ou 2, où ladite partie de liaison de chacun desdits éléments de chemise (10) possède la forme d'un arc de cercle (12) et est orientée sur une tangente de la partie cylindrique circulaire (11) dudit élément de chemise (10) de façon à ce que l'ouverture centrale (18) devienne circulaire.
4. Un assemblage de chemise de cylindre selon une des revendications 1 à 3, où lesdits moyens aux extrémités opposées de chaque partie de liaison comprennent une bosse (15) à une extrémité, laquelle forme une ouverture (16) qui s'étend dans une direction parallèle à la direction axiale et un doigt (17) à l'autre extrémité de ladite partie de liaison d'une forme qui correspond à celle de la bosse (15) d'une partie de liaison adjacente pour fixer radialement les uns aux autres les éléments de chemise (10).
5. Un assemblage de chemise de cylindre selon la revendication 4, où, vue en coupe radiale, ladite ouverture (16) et le doigt (17) ont une section en L.
6. Un assemblage de chemise de cylindre selon les revendications 1 à 5, où au moins un réceptacle d'axe (20) fait partie intégrante de chacun desdits éléments de chemise de cylindre (10).
7. Un assemblage de chemise de cylindre selon la revendication 6, où chacun desdits réceptacles d'axe (20) fait partie intégrante de la partie cylindrique circulaire (11).
8. Un assemblage de chemise de cylindre selon l'une des revendications 1 à 7, où chaque élément de chemise (10) est obtenu par extrusion.
9. Un assemblage de chemise de cylindre selon la revendication 8, où chacun desdits éléments de chemise (10) est en aluminium.

FIG. 1

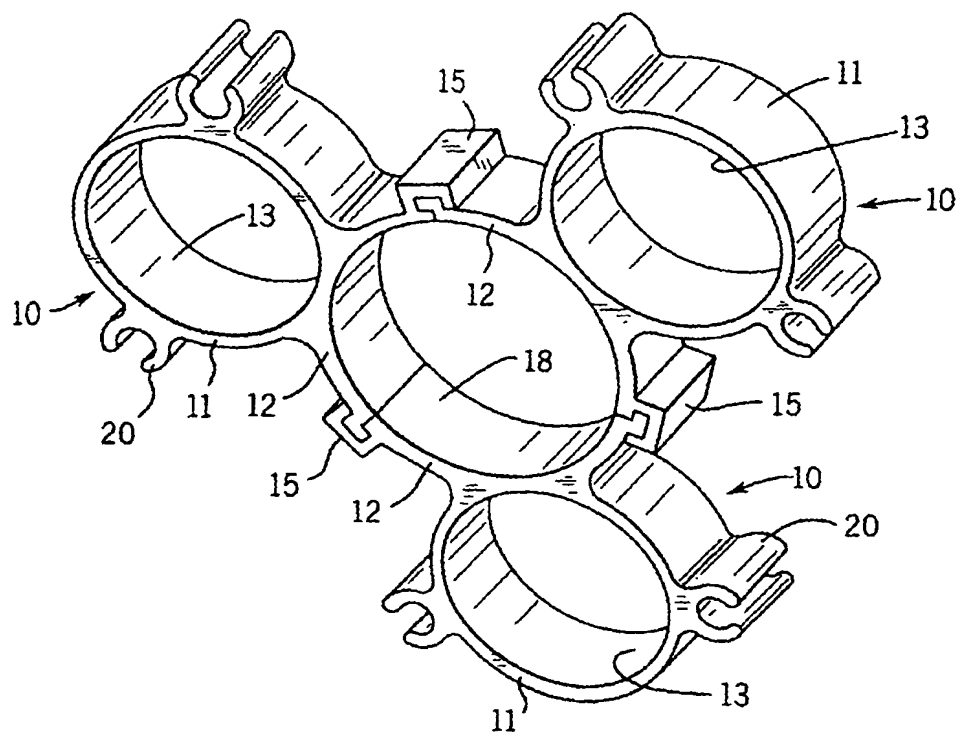


FIG. 2

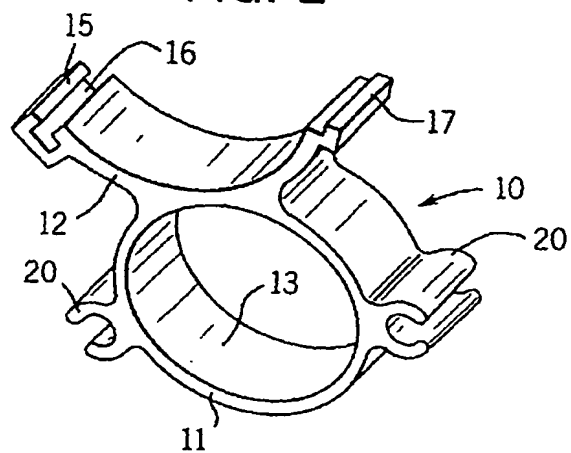


FIG. 3

